Take Our Daughters And Sons To Work® Foundation

Activity Guide

Includes Activities for all ages

CHALLENGE LEVEL 3

Explore STEM with

NC STATE Engineering

WARNING: These STEM activities have been known to cause extreme excitement. Some have even reported increased brain activity and a new love for Engineering!
This adventurous guide was brought to you
by North Carolina State University Engineering.

*Activities in this guide will require materials and supervision.

TAKE OUR daughters and sons TO WORK® FOUNDATION

Parental Authorization

(Parent/Guardian must complete and give to the accompanying adult if it is not the parent or some school systems require them to be turned into home room teacher.)

I/We, the undersigned, grant our son/daughter _____ permission

(Name of Student)

to participate in an out-of-school educational activity as part of the **Take Our Daughters and Sons to Work® Day**.

Should a medical emergency arise while my son/daughter is participating in this field trip, the accompanying adult or I will be responsible for initiating medical treatment. I give permission for immediate treatment as required in the judgment of the attending physician.

If there are any changes to the information provided herein, it is the parent's responsibility to provide the updated information.

_____

Signature of Parent or Guardian

_____

Signature of Parent or Guardian

_____

Date

Special Note:

Parents/Guardians of students that are participating in the Take Our Daughters and Sons to Work® Day event should fill-in an Excused Absence Form if your school need

What is Engineering?

Have you ever solved a problem? Maybe you have solved a homework problem in math or science. But what about a problem like how to do your chores faster or how to reach something on a tall shelf? Engineers solve society's problems, and their work is all around you!

Name Something Engineers Help to Create

E— Earphones

N—

G—

I—

N—

E—

E—

R—

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GETTING AROUND – Take a look at your tennis shoes — what do you use them for? Can you list all of the materials in your shoe? Can you find different kinds of tennis shoes and compare their features and tread? How are they different? Engineers develop lighter and stronger materials that allow your feet to breath and design shoes to perform the best for different types of activities like running, basketball and skateboarding.

STAYING WELL – Have you ever had an x-ray at the doctor's office or dentist? You probably got to see your tissue and bones! Lots of engineers work to develop the machines that take these images. Engineers also design things like electronic thermometers, hearing aids and tiny robots so small that they can be used for surgery!

YUMMY ON THE TUMMY – We all love a great candy bar or piece of chocolate, but where and how are they made? Engineers design equipment to make your favorite candies and foods, as well as design processes that don't waste ingredients and produce the freshest, best-tasting treats! They might also be involved in developing the packaging that your candy is wrapped in — from the materials to the shape and design!

CHEMICALS AT WORK – Have you ever wondered how that sticker on your apple stays on during shipping and at the store but comes off so easily when you are ready to eat it? Engineers develop new chemicals and materials that make our lives easier — like the stuff in diapers which makes them absorb liquids, glue that can be used on your skin instead of stitches and solar cells that can collect the sun's energy.

GAMES, GAMES AND MORE GAMES – Have you ever played games on a Nintendo Wii™ or a Playstation®? Engineers and Computer Scientists not only designed the box, the guts and the handsets, but they also designed all of the software tools for the graphics, menus, sounds and actions! Next time you play, thank an engineer!

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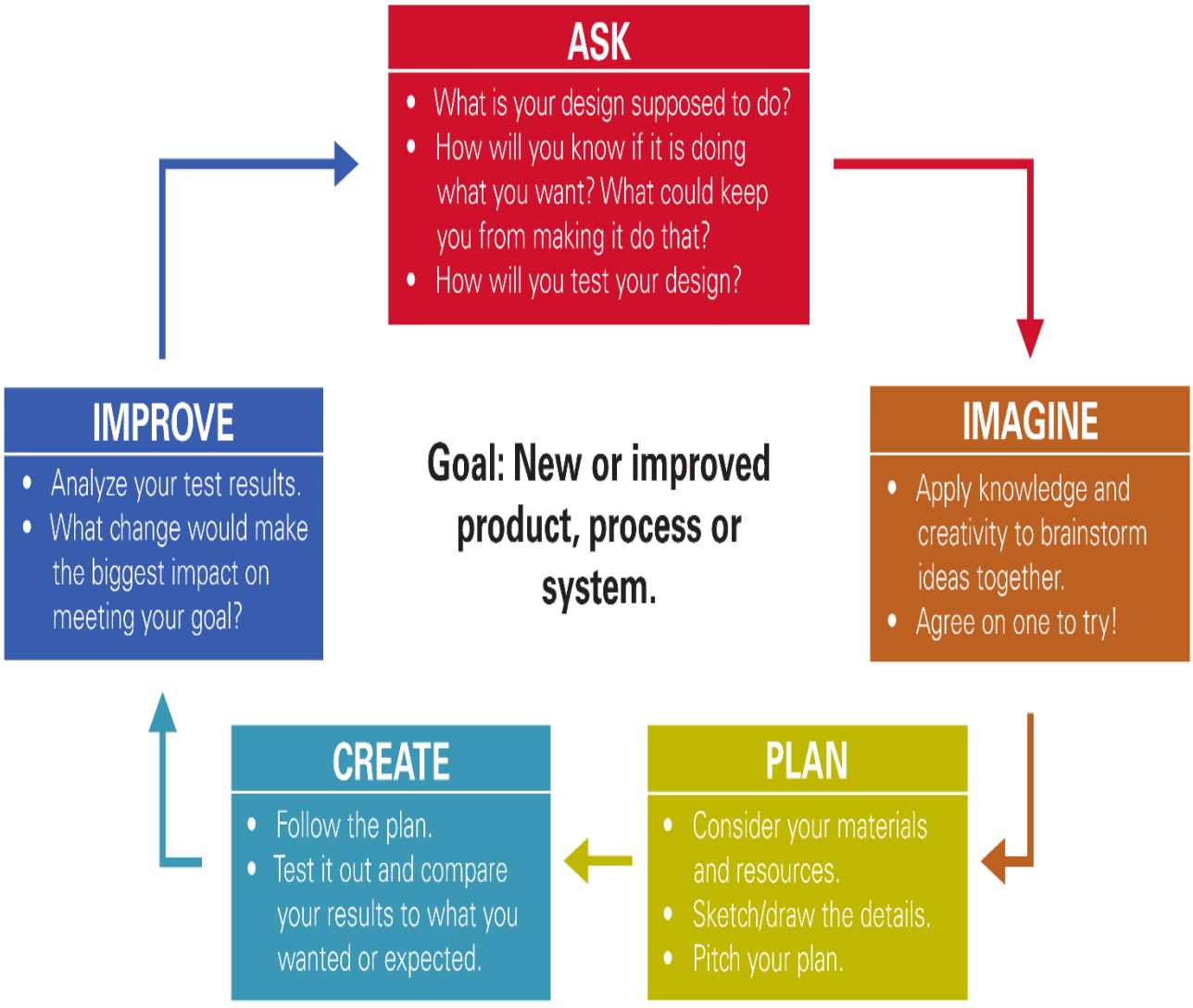
The Engineering Design Process



- The engineering design process is a series of steps that you repeat to develop or improve a product, process or system. You can start anywhere in the process, however, most engineers begin at **ASK** or **IMPROVE**.
- Failure is always a part of the process ... so is learning from failure!

the engineering place

Design process adapted from the Museum of Science Boston "Engineering is Elementary" program.

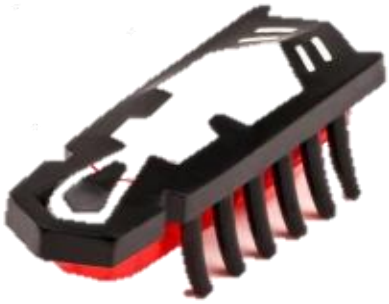
NanoBug Labyrinth

Objective: To design a maze that a Nano Bug can successfully navigate with the most elements and shortest times possible.

Materials:
- NanoBug
- Miscellaneous scrap materials

Tools:
- Masking Tape
- Scissors
- Timer

Activity Details: Each team will be given one NanoBug. You team is to design a maze that includes the following elements:



- ❑ One entrance and exit - can either be the same spot or separate areas for entrance and exit.
- ❑ 2 right angles
- ❑ A hill – any elevation change
- ❑ A tunnel
- ❑ A loop – any continuous circular path in which the NanoBug changes at least 180° direction.
- ❑ Sound change – any part of the maze that changes sound when the Nanobug goes through that part of the maze.
- ❑ Obstacle to go around
- ❑ A dead end
- ❑ A moving obstacle – an object that moves when the NanoBug comes in contact with it.

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NanoBug Labyrinth - Continued

Test Process: The NanoBug must complete the maze with the elements listed above in the least amount of time. The team whose NanoBug completes the maze in the shortest amount of time and has the most elements wins! In order for an element to count, the NanoBug MUST go through all the elements, excluding the dead end. Remember, 8 elements beats 7 elements regardless of time.

ENGINEERING DESIGN CYCLE

ASK: What do we need to know to get started? What are we trying to accomplish?

IMAGINE: How are we going to complete the task?

PLAN: What materials will you use? Draw a diagram of your design below.

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NanoBug Labyrinth - Continued

ENGINEERING DESIGN CYCLE

CREATE: Carry out your plan and test your maze. Was it successful? Why or why not?

Final time? _____ Sec.

Number of elements completed? _____ Elements

IMPROVE: What was good about your maze design? What can you make better?

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Save the Space Station!

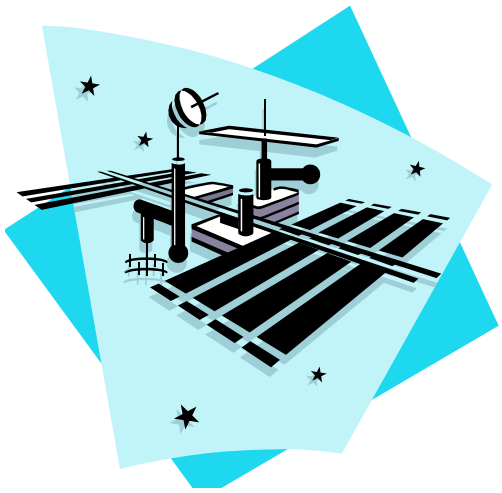
Objective: Construct a rocket that can get as many air canisters as possible up to the space station in one trip!

Materials:

- 3 long balloons
- 2 straight straws
- 50 small paper clips
- Paper Cup
- Sandwich bag

Tools:

- Masking Tape
- Clothespins
- Timer



Activity Details: The International Space Station burst an air tank! Until it can be repaired we need to send up as many air canisters as possible! Find a way to attach air canisters (a.k.a. paper clips) to a rocket that can reach the ISS (a.k.a. ceiling).

Test Process: The 'launch pads' will be set up in each room so that everyone can test. Slide the straw onto the fishing line and then hold the fishing line down so it cannot move. When ready to launch be sure to release the clothespins at the same time. The team who can get the most paper clips to the ceiling in the fastest time wins.

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Save the Space Station! - continued

ENGINEERING DESIGN CYCLE

ASK: What are we being asked to do? What are the constraints?

IMAGINE: How are we going to complete the task?

PLAN: Draw a diagram of your design below. List the materials you will use.

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Save the Space Station! - continued

ENGINEERING DESIGN CYCLE

CREATE: Carry out your plan and test your design.

How many air canisters (paper clips) reached the ceiling? _____

Time? _____sec.

How high did it get? _____in.

Average velocity? _____in/sec

Was your design successful? Why or why not?

IMPROVE: What was good about your design? What can you make better?

Snack Attack

Objective: To gain an understanding of the factors involved in designing cost conscious, environmentally friendly, and effective food packaging.

Materials:

- Cardboard
- Aluminum foil
- Wax paper
- Plastic wrap
- Small foam plate
- Toothpicks
- Paper towels
- 2 graham crackers
- 1 piece of chocolate
- 1 large marshmallow

Tools:

- Stapler
- Scissors
- Tape

Activity Details: A new candy company wants to package individually wrapped, ready to heat S'mores that can stay fresh in the wilderness or on a camping trip. Engineers have been working on the problem and developed some designs to be tested. After the first part of testing, the biggest problems are with making the package weather proof. Design a package to protect a S'more from HEAT AND WATER.

Snack Attack - Continued

Test Process: Working in groups of 2 or 3, using the **Experiment and Cost Activity Sheet,** plan a package that your group feels will best protect your S'more form heat and water.

Write down the materials you need figure the total cost per item and then add up the total for the entire package.

Submit your cost sheet to your team leaders, they will assign a 'cost score' to each group, based on the overall expense of the package. The most expensive package gets 1 point, the least gets 8 points (if there are 8 groups) the rest are ranked in order of costs.

Next, take your group's completed material list/cost sheet to the 'store' to 'purchase' the materials you have selected. Construct your package.

After you complete the package, turn to the **Test Instructions Activity Sheet**. Take your package to each test station to be tested. After the testing, unwrap the package and look at the results. Fill in the form based on the results you see.

Snack Attack - Continued

Experiment and Cost Activity Sheet

Team Members :_____

Experiment: Create a package that will keep your S'more cool and dry. It will need to keep your chocolate and marshmallow from melting during the heat test (45 seconds under a hair dryer on high). Your package will also need to keep your graham cracker and marshmallow dry when 1 cup of water is poured over it. Cost is another concern. Engineers want to design good packages at the lowest possible cost. You have a budget of **50 cents** which means you can not spend more than 50 cents on your package, but you can spend less.

Scoring: Your package will be scored in two ways:

Test performance*:* Your package will be rated from 0 to 40 based on how well it performs in the two tests.

Cost: Your package will get a cost rating from your team leader or the "store manager". The package the costs the least (which is what you want) will get more points. The Package that costs the most will get the lowest number of points. Hand in your cost Sheet to receive your "cost score".

ITEM	QUANTITY	COST PER ITEM	TOTAL COST
Cardboard pieces (3 inch square)		10 cents each	
Aluminum foil (6 inch square)		8 cents each	
Wax paper (6 inch square)		5 cents each	
Plastic wrap (6 inch long piece)		10 cents each	
Small foam plate (cut in half)		15 cents each	
Toothpicks		2 cents each	
	TOTAL	Cannot be more than 50 cents	$

Snack Attack - Continued

Test Instructions Activity Sheet

Team members: _____

1. You may place a small piece of tape on the bottom of each package (to prevent movement when blow drying) and place it in the center of the baking pan.
2. Bring your package to the "heating testing station".
3. The team leader will set the top package on a flat surface and hold the hair dryer 6" from the top of the package directly over the package and blow dry on the "high" setting for 45 seconds.
4. Next take the package to the water test station
5. The team leader will hold 1 cup of water 6" from the top of the package, directly over the package, and then pour it over the top of the package.
6. Unwrap the package and look at the results
7. Based on the results of the test, fill in the form below.

Heat Test

Chocolate

Not melted (solid):	10 points
Partly melted:	5 points
Completely melted:	0 points
	Points Awarded_____

Marshmallow

No browning:	10 points
Partly or completely brown:	0 points
	Points Awarded_____

Water Test

Graham Crackers

Dry:	10 points
Damp:	5 points
Wet:	0 points
	Points Awarded_____

Marshmallow

Dry:	10 points
Damp:	5 points
Wet:	0 points
	Points Awarded_____

Cost Score Points Awarded _____

(get this from "Experiment and Costs" Activity Sheet

Snack Attack - Continued

ENGINEERING DESIGN CYCLE

ASK: How can we make a cost efficient package that is environmentally friendly and protects the S'more from the elements?

IMAGINE: Describe what your S'mores package will look like. What materials do you think you will need?

PLAN: Draw a diagram of your design below. What are the roles of everyone in your group?

CREATE: Carry out your plan and test your design. Was it successful? Why or why not?

IMPROVE: What was good about your design? What can you make better?

NC STATE Engineering

Exploring Sound with Resonance Chambers

Lesson Plan Developed by: Laura Bottomley

Objective: The students will observe how a resonance chamber can demonstrate the wave nature of sound. They will then use observation skills to explore different pitches and the relationship to frequency of waves.

Overview:

- Scientific Method
- Wave nature of sound
- Energy (sound as energy)

Materials:

- 12 oz plastic cups, one per student
- 10 in or 12 in balloons, one per student
- Pepper, salt and/or other granular materials
- Scissors
- CD player and various types of music
- (preferred) a small piano-type keyboard or some other device capable of producing single pitches, like tuning forks

Background Information: Decide whether you want to pre-cut the balloons or allow the students to do them. If the students have trouble stretching the balloons, it is good to have an extra adult on hand to help. After the chambers are made, it is good to pair them up for the exploration phase.

Activity (Explore):

Begin by talking about energy:

- Sound carries energy.
- Ask the students to brainstorm all the things they know about sound. Make sure that they recognize that sounds have different pitches and different volumes. Make sure they recognize the difference between pitch and volume by making or playing a few different notes at different pitches and volumes. Play or sing a single pitch loudly and softly and ask the students what the difference is between them. Elementary students will sometimes mistake volume changes for pitch changes.
- Note that some sounds do not have a particular pitch associated with them. These are percussive sounds. In speech, percussive sounds include t's and k's. You can make percussive sounds by clapping or rapping two pencils together. (Percussive sounds are really made up of many pitches combined.)
- We are going to investigate sounds by making a resonance chamber—a closed container that will resonate to sound.
- Then we will use the chambers in a short experiment using the scientific method to explore sound.

Exploring Sound with Resonance Chambers -continued

Procedure:

1. Cut the neck off of your balloon just after it starts to open up into the circular part. Discard the neck in the trashcan.
2. Insert the tips of the fingers on both hands into the balloon and stretch it over the open end of the plastic cup. It should fit tightly. If it breaks, get another balloon and cut off a bit more of the neck of the balloon next time. If it is too loose, get another balloon and cut off less next time.
3. You now have a resonance chamber. Put your mouth near the bottom of the cup (that does not have balloon on it), and speak into it. Do you hear your voice bouncing around in there? Sound bounces. That is the reason you can hear someone speak who is around the corner from you. It is also what causes echoes.
4. Place your cup on the desk with the balloon side on top. Put a little bit of pepper or other granular material on the balloon. Talk into the side of your cup and have a partner watch what happens to the pepper. Trade places, and you look too.
5. What do you think will happen to the pepper if you make a high-pitched sound into the cup and a low-pitched sound into the cup? Write down your hypothesis. Then try it, again taking turns observing with your partner. Write down a description of what happened. Try different pitches and different volumes. Try percussive sounds. If you have access to tuning forks, strike one gently on your desk and touch it gently to the side of your cup. Watch what happens.
6. When your teacher turns on the CD player, predict what will happen if you put your cup with the pepper on top in front of the speaker. Try it, and record what you observed.
7. Talk with your partner and explain what happened to the pepper. Use words like pitch and volume in your explanation. If you think it makes sense, draw some pictures of what you observed the pepper doing.

Discussion: The students will observe different things as they go through the activity. The goal is for them to accurately record in writing and/or pictures the different things they see. Most of them will notice that the pepper jumps when sound are made into the cup. The more observant of them will notice that a single pitch sung or played into the cup produces a circular pattern of pepper rings on top of the balloon. Higher pitches make those rings closer together, and lower pitches further apart. Percussive sounds make more random looking patterns on the balloon.

Questions:

Q: What are the steps to the Scientific Method?

A:

1. The Problem – Ask questions and gather facts.
2. The Hypothesis – Make a reasonable guess to the problem.
3. The Experiment – Plan (this includes a material list) and conduct the test.
4. Data – Gather data and compare to the hypothesis.
5. Conclusions—Explain why you got the results you got in your experiment. Confirm that you really tested what you meant to test.
6. Investigate Further – Determine if data can be replicated or if others found similar results.

Closure: Scientists use the Scientific Method every time they perform an experiment.

10 Great Reasons to Become an Engineer

NC STATE Engineering

Engineering involves the application of creativity in partnership with math, science, social studies, language arts and fine arts to search for quicker, better and less expensive ways to use the forces and materials of nature to meet today's challenges. Engineers are problem solvers who use every resource possible to bring into existence things and ideas they imagine.

1. Engineers work to solve global problems such as world hunger, clean water, protecting the environment and improving the quality of everyday life.

2. Engineering allows you to use your creativity every day.

3. Engineering gives you the chance to collaborate with other professionals such as lawyers, doctors, government officials, scientists, statisticians and more.

4. Engineering is a global endeavor, frequently affording the opportunity for travel.

5. Engineers have the opportunity for rapid advancement in their companies.

6. Engineers frequently have a high level of responsibility and autonomy in their positions.

7. Engineering salaries remain high.

8. Engineering degrees provide excellent preparation for other professional degrees such as medicine, law or business.

9. While working as a scientist frequently requires advanced degrees, engineers are very employable with a bachelor's degree.

10. Engineering has more impact on the world than any other profession.

Directions for Completing the Take Our Daughters And Sons To Work® Day Assignment

Please use the forms (Take Our Daughters and Sons to Work® Day Activity Log and the Post-Take Our Daughter And Sons To Work Day Evaluation Form) to document the activities that you participated in on Take Our Daughters And Sons To Work® Day. Include the time, activity and the adult who supervised you while involved in the activity. A sample has been completed for you.

Activity Log

Student Name _____

School Grade _____

Workplace _____

TIME	ACTIVITY	RESPONSIBLE ADULT
8:00-8:30	Tour of OFFICE BUILDING	

* (Use if the group leader asks you to).

Evaluation Form

Your Name_____ Date_____

Name of Company_____

Fill in the blanks. Share your answers at home with your family.

1. This is the most unusual or surprising thing I saw:

2. One job I saw was:

3. The job helps people because:

4. The following school work will help in doing this job:

5. This is an example of an important work habit:

6. This is an example of a team project I learned about at the work-site visit:

7. Of all the jobs I saw, I think I would be best at:

Program Form

Let us know what you think about the Take Our Daughters And Sons To Work ® program and you may appear on our Web site. Please answer the following questions and mail this form to the address below.

1. What did you learn on Take Our Daughters And Sons To Work Day?

2. Finish this sentence: I love Take Our Daughters And Sons To Work Day because…

3. What did you learn about your parent/sponsor?

4. Finish these sentences:
   My future work…

   My future family…

   My future community…

5. What do you think it would be like to work and take care of a family?

6. What company or organization did you attend and what did you learn about the workplace?

Full Name _____
Parent/Sponsor Name _____
Parent/Sponsor Phone Number _____
E-mail Address _____
Email To: **todastw@mindspring.com**